569

The KNOWLTON WATERTOOB STEEL HEATING BOILER

DESIGNED ESPECIALLY *for* OIL BURNERS

Bulletin "P"

MANUFACTURED BY

ORR & SEMBOWER, INC.

READING, PA., U.S.A.

CHICAGO WAREHOUSE
208-212 N. CLINTON ST.

NEW YORK OFFICE
50 CHURCH ST.

ST. LOUIS WAREHOUSE
419-429 S. 12TH ST.

Established 1885

A.I.A. FILE No. 30-C-1

W. HARRY ORR, PRES. J. HARRY STITELER, TREAS. G. K. SEMBOWER, SECY.

ORR & SEMBOWER, INC.
MANUFACTURERS OF
"O & S" PRODUCTS
READING, PA.

June 9, 1932

T. B. Cryer Company
249 High Street
Newark, New Jersey

Gentlemen:

We herewith submit additional information covering boilers in bulletin No. 1000.

Thickness of Boiler Shell - 1/4"
Thickness of Heads - 5/16"
Thickness of Shell Insulation - 1" Rock Wool

	#100 & 150	#200 & 250	#300 & 350
Number and Size 2"-#13 Gauge Tubes	26-27" Long	38-31" Long	55-31" Long
Approximate Shipping Wgt. without Combustion Chamber	950	1250	1550
Approximate Shipping Wgt. with Combustion Chamber	1150	1525	1900

Very truly yours,

ORR & SEMBOWER, INC.

G. K. Sembower

Secretary.

GKS/BD

COPYRIGHT 1930
ORR & SEMBOWER, INC.
READING, PA., U. S. A.

FOREWORD

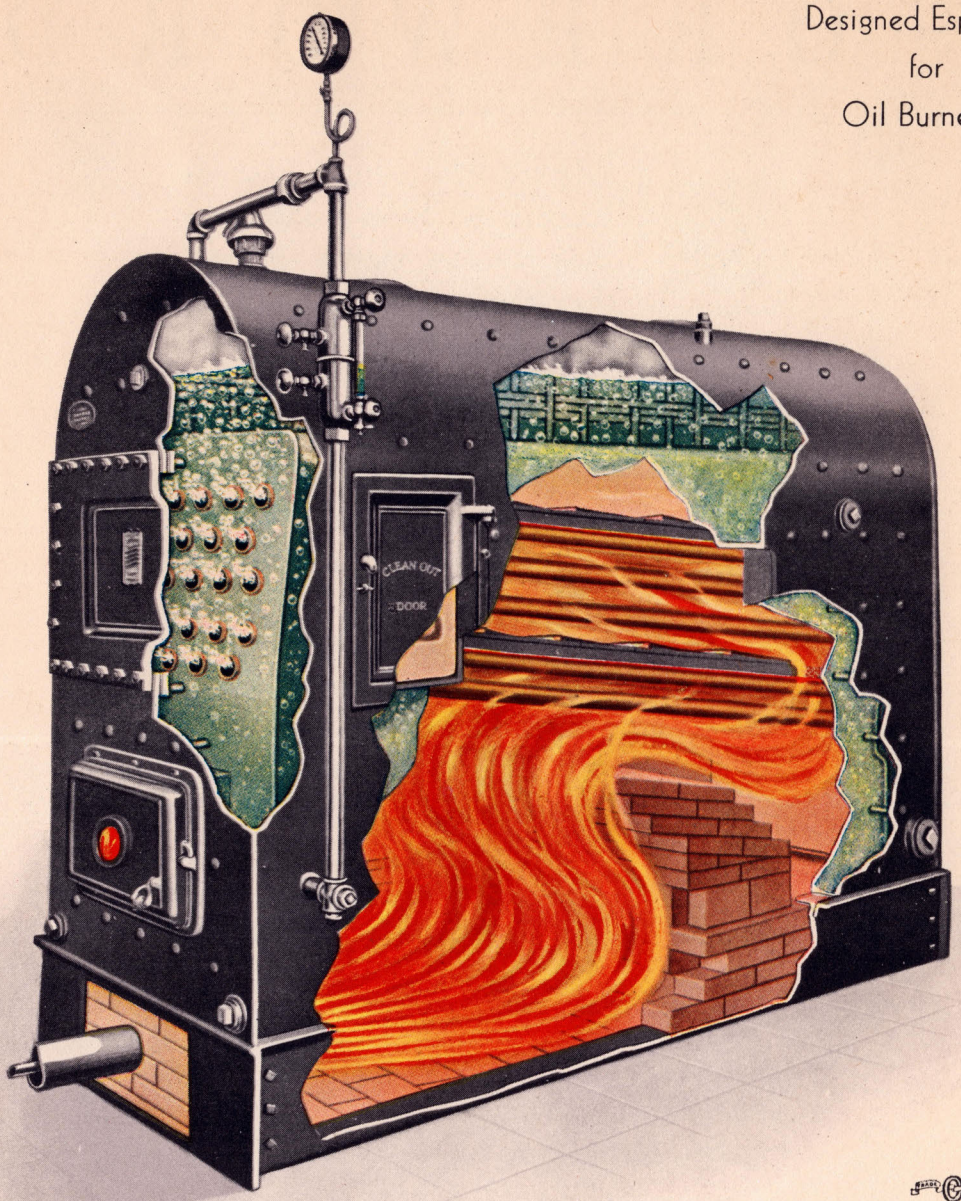
CRAFTSMEN whose business success has been built upon their constant desire to serve their clients best---home owners and home builders whose first thought is always for the supreme comfort of their families and themselves have been the inspiration that finds its expression in the Knowlton Watertoob Steel Low Pressure Boiler, designed especially for oil burners. Back of the perfection of this efficient heating unit is found over forty years of boiler-making experience. Orr & Sembower, Inc., started making high-pressure boilers back in 1885, and have been successfully engaged in their manufacture ever since.

"O & S" products enjoy a splendid reputation, and may be found in all the civilized countries of the world.

You will find in the Knowlton Watertoob Steel Boiler all that you would expect in a heating unit. It offers Complete Heating Satisfaction.

The Knowlton Watertoob Steel Heating Boiler

Designed Especially
for
Oil Burners



All ratings for these boilers, and printed in this bulletin, have been determined by Performance Tests conducted in the Frost Research Laboratory, Norristown, Pa.

The latest rules for tests, as prescribed by the American Society of Heating and Ventilating Engineers, and accepted by the Heating and Piping Contractors National Association and the Certified Heat Association, were followed, and all types of oil burners were used.

Description

The Knowlton construction not only meets the requirements of the boiler code of the American Society of Mechanical Engineers, but exceeds it in the thickness of metal used.

The plates of the Knowlton Watertoob Steel Boiler are first beveled and then electrically welded, fusing all of them into one solid unit. The possibility of leakage in this way is reduced to a minimum.

Copper bearing steel is used throughout. The addition of a small amount of copper to steel tremendously increases its resistance to corrosion. This has been proven beyond doubt.

This boiler is equipped with copper tubes, which insure quick action. This is essential because the burner is either on or off, and when started, has a peak load condition each time. The quick action of the Knowlton reduces this burden to a minimum.

The use of many tubes of a small diameter, permits of more rapid heat absorption than would be possible with fewer tubes of large diameter. This rapid absorption of heat quickly raises the temperature of the water, thereby increasing its circulation. The circulation of the water is further accelerated because the tubes are set at the proper angle instead of being placed horizontally. As the water is heated, it becomes lighter and rises. If the tubes were horizontal, or placed at an improper angle there would be more friction in them, and consequently poorer circulation because of the tendency of the hottest water to cling to the top of the tubes in an effort to go through them.

By inclining the tubes, the rising energy of the water is put to use. The heated water as a body rises to the upper ends of the tubes and the cold water enters the lower ends to replace it, establishing a constant and rapid circulation.

The gases are forced to pass back and forth over the tubes by means of two rows of baffles, each made in sections. This is equivalent to a travel of about three times the length of the fire box. This long gas travel heats the water to a degree that would otherwise be impossible. The baffles can be easily removed for the purpose of cleaning the boiler.

It is known as "The Oil Saving Boiler."

Ratings Established By Performance Tests

Ratings should represent the true heating power at the point of boiler outlet, and measured in B. T. U's. per hour. There are three important ratings that should be determined for each boiler, namely—

Maximum Capacity
Designed Load
Net Load

Various methods have been used to determine these ratings, and finally after careful study and consideration, the various engineering and contracting societies of the country have decided that all boiler ratings shall be determined by actual Performance Tests. This method of procedure is absolutely sound, for it is fair for all producers of boilers, inspires more confidence in the Architect, Engineer, or Contractor, who specifies the boiler, and assures the customer of getting a tried and proven article.

Perhaps the best method of procedure is to arrange to have these Performance Tests conducted in a disinterested laboratory, rather than in the manufacturer's plant, and by a recognized authority, who is qualified to conduct Performance Tests according to the latest rules as prescribed by the various heating societies. If this procedure were followed by all manufacturers, the National Rating Committee would be relieved of a great responsibility. It would mean considerably more than the mere statement that one boiler is better than another, and would have a tendency to promote the development of better boilers.

We have tried to be extremely conservative in publishing ratings on Knowlton Watertoob Steel Heating Boilers, and therefore were confident that the results of a Performance Test, conducted by an authorized boiler authority, would prove highly satisfactory and justify all we have said and published on the subject. After several conferences with officials of various heating organizations, it was decided to place the boilers in the Frost Research Laboratory, Norristown, Pennsylvania, where the tests could be conducted under the supervision of Mr. R. V. Frost.

The reports shown on pages 12 to 15 inclusive, show the actual test data on each boiler, as determined by Mr. Frost. The report on page 11 shows the Designed Loads recommended by Mr. Frost, and also the Net Loads that we guarantee, and suggest be used.

The Designed Loads are absolutely guaranteed to be correct as shown in this bulletin, and for the purpose of selection, are intended to correspond to the sum of items A. B. and C.

A. The estimated normal heat emission of the connected radiation required to heat the building as determined by accepted practice, expressed in square feet of radiation or B. T. U's. per hour.

B. The estimated maximum heat required by water heaters or other apparatus connected to the boiler, expressed in square feet of radiation or B. T. U's. per hour.

C. The estimated heat emission of pipes connecting radiation and other apparatus to the boiler, expressed in square feet of radiation or B. T. U's. per hour.

The above method has been used rather freely, and may be used with absolute safety in connection with Knowlton Boilers. We believe however, that in addition to the sum of A. B. and C., a satisfactory and carefully determined safety factor should be used. The use of safety factors has been part of an educational program sponsored by the various heating societies and if universally adopted, would eliminate many of the heating troubles. For this reason, we show Net Loads that we recommend be used in selecting the proper boiler for the job. Net Loads represent the sum of A. and B. only, and you will note that the difference between the Net and Designed Loads is considerably greater than C., and consequently includes safety factors. It is therefore very important to know whether Designed or Net Loads are under consideration before choosing the proper boiler.

You will note that the individual test reports on pages 12 to 15 inclusive, show boiler ratings, which run from 25 to 45 per cent. higher than the guaranteed Designed Loads. Even at these high points, the efficiencies of the boilers have only dropped a few points. This indicates exceptional overload capacities beyond the Designed Loads, and we guarantee that they are large enough to take care of more than a normal starting load condition.

We further emphasize the fact that higher efficiencies can be obtained on Knowlton Boilers by purely Laboratory Tests, but since these were Performance Tests, the higher points of efficiency were ignored.

While we were certain that the Knowlton design was very nearly correct, the constructive criticism of qualified outside Engineers, while the tests were being conducted, resulted in enlarging several of the smoke outlets. This improvement reduces the drafts as shown, although the corrections were not made until after all of the tests had been completed, and therefore the benefit of these changes is not shown on the printed test reports.

Radiation

In designing a heating system, the first consideration is the amount of radiation required. The most exact method for doing this is termed the B. T. U.method. There are other rule of thumb methods in vogue, but the B. T. U. method recommended by the American Society of Heating and Ventilating Engineers Guide, and adopted by the Heating and Piping Contractors National Association in their Engineering Standards, is based upon the rate of heat transfer through materials used in building construction.

Details of the method of calculating radiation on this basis will be found in the above mentioned editions.

A short rule that gives excellent results over the average heating range of zero outside to 70 degrees inside temperature is the 3-9-180 rule.

The sum of the glass surface in rooms divided by 3, exposed wall divided by 9, and cubic contents divided by 180 equals the total steam radiation required, with the exception of allowances for exposure, concealed radiators or room temperatures in excess of 70 degrees.

The following allowances and additions to the above rule should be made:—

1. Floors and ceilings exposed to weather to be figured same as exposed walls.
2. Floors and ceilings exposed to unheated rooms figure as one-half exposed wall.
3. Figure all bath rooms to 80 degrees.
4. Triple the cubic contents of stores, lobbies or rooms where outside doors are opened frequently.
5. Add 10 per cent. for northern exposure or prevailing winds.
6. Add 6 per cent. for each 5 degrees in excess of 70 degrees inside temperature.
7. Add 15 per cent. for each fire place.
8. Add 20 per cent. for radiation under seats.
9. Add 20 per cent. for radiator on inside wall in exposed rooms.
10. Add 25 per cent. for direct indirect radiation.
11. Add 50 per cent. for indirect radiation.
12. Add 60 per cent. to total radiation after additions have been made in order to obtain the square feet of water radiation required.

In GREEN HOUSE HEATING the following factors may be used:

Outside temperature	0° F.	0° F.
Required temperature	40° to 50° F.	50° to 70° F.
One sq. ft. of direct Steam Radiation to each	5 to 6 sq. ft. glass or equivalent wall	4 to 5½ sq. ft. glass or equivalent wall
One sq. ft. of direct Water Radiation to each	3 to 3½ sq. ft. glass or equivalent wall	2½ to 3½ sq. ft. glass or equivalent wall

Heating Hot Water

In heating hot water with external heater and tank the following factors may be used to determine boiler size:

Temperature rise of water per hour degrees F.	20°	30°	40°	50°	60°	80°	100°	130°
Capacity per square foot direct steam radiation—gallons	1.5	1.0	0.75	0.6	0.5	0.37	0.3	0.23

Example:

Boiler capacity required to raise temperature of 400 gallons of water 50 degrees per hour $= \frac{400}{0.6} = 665$ sq. ft. steam.

Knowlton Boilers can be equipped with the McDermott Submerged Water Heaters, and if separate tank is used and which we recommend, it is only necessary to count upon one-half foot of steam radiation for each gallon of water heated every three hours at a temperature rise of 100° F.

The following average hot water consumption per hour per fixture in gallons at 160° F. final temperature is given in the form of public buildings and residences. Public buildings include gymnasiums, hospitals, hotels, laundries, office buildings, public baths, schools, Y. M. C. A. and clubs.

Fixtures	Public Buildings	Residences
Private Lavatory	3	1.5
Public Lavatory	10 to 15	
Bath Tubs	30	10.0
Foot Basin	5	1.5
Kitchen Sink	20	5.0
Laundry—Stationary Tub	35	12.5
Laundry—Revolving Tub	150—300	37.5
Shower	200	50.0
Slop Sink	20	50.0
Mechanical Dish Washer	300	10.0

Total per cent. of hot water for all fixtures likely to be drawn at one time will average as follows:

Gymnasiums, laundries, public baths and Y. M. C. A., 90 to 100.

Others with exception of residences 60 to 70.

Steam Requirements For Restaurants or Hotel Kitchens

The table following gives the requirements of the various units in horse power. The sum total of these that will be used in any one hour, plus a reserve capacity of 33⅓ per-cent. for friction, heat loss and emergencies, will determine the steam boiler capacity.

Bain Marie, per each foot	1	H. P.
Coffee Urns, for each 10 gallons	½	H. P.
Kettle, stock, 40 gallons	2	H. P.
Kettle, stock, 60 gallons	2½	H. P.
Kettle, stock, 100 gallons	4	H. P.
Steam Table, each 6 feet	1½	H. P.
Clam and Lobster Steamer	1	H. P.
Jet for Pot Sink	1½	H. P.
Vegetable Boiler (direct)	1½	H. P.
1 to 4 bushel Vegetable Steamers	1	H. P.
Dish Washer	1	H. P.
Cup Warmer	1½	H. P.
Silver Burnisher	2	H. P.
Plate Warmer, 5 x5 x 1 feet	1½	H. P.
Steamer, 3 compartments	2	H. P.
Water for each 100 gallons, raised 130 degrees temperature	3½	H. P.

Requirements For Dairy Work

Can Washer	15-20	H. P.
Ladd Blue Line Jr. Bottle Washer	15	H. P.
Ladd Blue Line 6-2nd Bottle Washer	6	H. P.
100 Gal. Capacity Pasteurizer	6	H. P.
200 Gal. Capacity Pasteurizer	8	H. P.
300 Gal. Capacity Pasteurizer	12	H. P.
500 Gal. Capacity Pasteurizer	15	H. P.

Heating data contained in this section is not guaranteed, but is based on standard authorities.

All Performance Tests conducted by
THE FROST RESEARCH LABORATORY,
Norristown, Pa., U. S. A.

WORKING PRESSURES
15 lbs. Steam—30 lbs. Water

B. T. U. per lb. of Oil 19400
Wht. of Oil, 7.2 lbs. per gal. at 70°

RATINGS—KNOWLTON WATERTOOB BOILERS

BOILER NUMBER	20	21	22	23	24	25	26½	27	27½	28	29	30	31	32	33	34
Output at Boiler Outlet, Thousands B. T. U. per hour	204	288	360	528	638	765	947	1130	1290	1450	1651	1993	2337	2737	2977	3160
Output at Boiler Outlet Guaranteed Designed Loads—Steam—sq. ft.	850	1200	1500	2200	2660	3185	3945	4710	5370	6040	6880	8300	9720	11400	12400	13160
Output at Boiler Outlet Guaranteed Designed Loads—Water—sq. ft.	1360	1920	2400	3520	4257	5100	6310	7530	8600	9680	11000	13280	15550	18240	19850	21070
Recommended Net Loads—Steam—sq. ft. in 70° F	630	890	1110	1695	2050	2450	3035	3625	4135	4650	5500	6640	7775	9120	9920	10530
Recommended Net Loads—Water—sq. ft. in 70° F	1010	1425	1775	2710	3280	3920	4855	5800	6615	7440	8800	10625	12440	14590	15870	16850
Output at Boiler Outlet, Lbs. Steam per hour	210	297	371	544	658	788	976	1162	1328	1492	1702	2050	2410	2815	3068	3257
Gallons Oil burned per hour	1.8	2.55	3.22	4.68	5.72	6.77	8.45	10.0	11.5	13.0	14.9	18.0	21.0	25.0	27.1	28.7
Water Evaporation per lb. of Oil—lbs.	16.2	16.2	16.0	16.1	16.0	16.2	16.0	16.2	16.0	16.0	15.9	15.8	15.95	15.6	15.7	15.7
Boiler Efficiency—per cent.	80.9	80.9	80.4	80.7	80.0	81.1	80.0	80.9	80.3	80.0	79.6	79.3	79.9	78.4	78.8	78.8
Flue Gas Temperature—degrees	441	480	523	572	597	535	570	565	595	615	620	627	613	625	640	634
Draft at Smoke Outlet—Inches Water	.02	.02	.02	.03	.04	.04	.04	.04	.04	.04	.05	.06	.08	.16	.22	.20
Size of Chimney—One Boiler	8x12 x30	8x12 x30	12x12 x30	12x12 x30	12x16 x30	12x16 x30	12x16 x30	12x16 x30	12x16 x30	16x16 x30	16x20 x30	20x20 x35	20x20 x35	20x20 x40	24x24 x60	24x24 x60
Size of Chimney—Two Boilers	12x12 x30	12x16 x30	12x16 x30	12x16 x30	16x16 x30	16x16 x30	16x20 x30	16x20 x30	20x20 x30	20x20 x30	20x24 x30	24x24 x35	24x24 x35	24x24 x40	24x30 x60	24x30 x60
Combustion Area—sq. ft.	2.50	3.83	4.80	6.50	7.58	8.45	9.67	11.27	12.09	12.88	14.11	16.90	19.98	22.51	25.0	25.0

PERFORMANCE TEST DATA

KNOWLTON WATERTOOB BOILER No. 20 Combustion Area 2.5 sq. ft.	1. Output at Boiler Outlet Thousands B. T. U. per hour	111	181	226	270	312	356
	2. Output at Boiler Outlet Sq. ft. Steam Radiation (240 B. T. U.)	463	754	942	1125	1300	1482
	3. Output at Boiler Outlet Sq. ft. Water Radiation (150 B. T. U.)	740	1206	1508	1800	2080	2370
	4. Output at Boiler Outlet Lbs. Steam per hour	115	187	234	279	322	369
	5. Gals. Oil burned per hour	1.00	1.60	2.00	2.40	2.80	3.20
	6. Evap. per pound Oil	16.0	16.2	16.2	16.1	16.0	15.9
	7. Efficiency—per cent.	79.8	81.0	81.0	80.7	80.0	79.5
	8. Flue Gas Temperature—°F.	340	415	467	518	568	618
	9. Draft at Smoke Outlet— Inches Water	.01	.01	.03	.06	.11	.18
	10. Size of Chimney	8x8x30	8x8x30	8x12x30	8x12x35	12x12x35	12x12x40
KNOWLTON WATERTOOB BOILER No. 21 Combustion Area 3.83 sq. ft.	1. Output at Boiler Outlet Thousands B. T. U. per hour	139	226	282	336	389	420
	2. Output at Boiler Outlet Sq. ft. Steam Radiation (240 B. T. U.)	581	942	1175	1400	1620	1751
	3. Output at Boiler Outlet Sq. ft. Water Radiation (150 B. T. U.)	930	1510	1885	2240	2598	2800
	4. Output at Boiler Outlet Lbs. Steam per hour	144	233	291	348	402	433
	5. Gals. Oil burned per hour	1.25	2.0	2.5	3.0	3.5	3.8
	6. Evap. per pound Oil	16.0	16.2	16.2	16.0	16.0	15.8
	7. Efficiency—per cent.	79.8	81.0	80.9	80.4	79.8	79.2
	8. Flue Gas Temperature—°F.	345	424	477	530	582	612
	9. Draft at Smoke Outlet— Inches Water	.01	.01	.02	.05	.10	.15
	10. Size of Chimney	8x8x30	8x8x30	8x12x30	8x12x30	12x12x30	12x12x30
KNOWLTON WATERTOOB BOILER No. 22 Combustion Area 4.8 sq. ft.	1. Output at Boiler Outlet Thousands B. T. U. per hour	167	254	310	363	416	468
	2. Output at Boiler Outlet Sq. ft. Steam Radiation (240 B. T. U.)	696	1060	1292	1510	1735	1950
	3. Output at Boiler Outlet Sq. ft. Water Radiation (150 B. T. U.)	1115	1700	2065	2420	2770	3120
	4. Output at Boiler Outlet Lbs. Steam per hour	173	263	321	376	430	485
	5. Gals. Oil burned per hour	1.50	2.25	2.75	3.25	3.75	4.25
	6. Evap. per pound Oil	16.0	16.2	16.1	16.0	15.9	15.7
	7. Efficiency—per cent.	79.8	81.0	80.7	80.1	79.5	78.8
	8. Flue Gas Temperature—°F.	357	430	478	527	576	624
	9. Draft at Smoke Outlet— Inches Water	.01	.01	.02	.03	.06	.12
	10. Size of Chimney	8x8x30	8x12x30	8x12x30	12x12x30	12x12x30	12x12x30
KNOWLTON WATERTOOB BOILER No. 23 Combustion Area 6.5 sq. ft.	1. Output at Boiler Outlet Thousands B. T. U. per hour	223	339	452	542	626	686
	2. Output at Boiler Outlet Sq. ft. Steam Radiation (240 B. T. U.)	929	1414	1880	2258	2610	2860
	3. Output at Boiler Outlet Sq. ft. Water Radiation (150 B. T. U.)	1487	2262	3010	3610	4170	4570
	4. Output at Boiler Outlet Lbs. Steam per hour	231	351	467	561	648	710
	5. Gals. Oil burned per hour	2.0	3.0	4.0	4.8	5.6	6.2
	6. Evap. per pound Oil	16.0	16.2	16.2	16.1	16.0	15.9
	7. Efficiency—per cent.	79.8	81.0	80.9	80.6	80.0	79.4
	8. Flue Gas Temperature—°F.	365	442	520	580	644	690
	9. Draft at Smoke Outlet— Inches Water	.01	.01	.02	.04	.07	.11
	10. Size of Chimney	8x8x30	8x12x30	12x12x30	12x12x30	12x16x30	12x16x35

PERFORMANCE TEST DATA

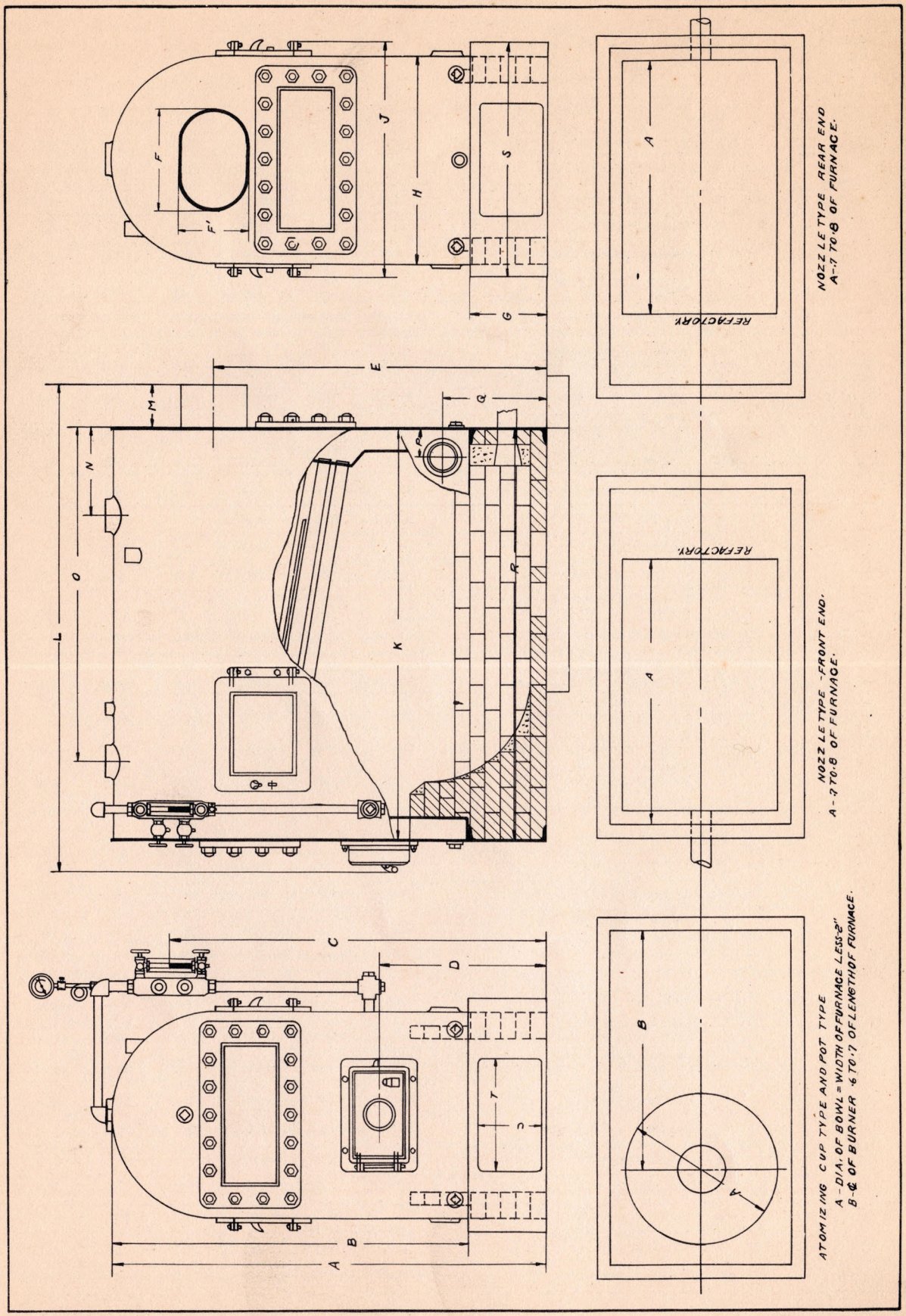
KNOWLTON WATERTOOB BOILER No. 24 Combustion Area 7.58 sq. ft.	1.	Output at Boiler Outlet Thousands B. T. U. per hour	242	396	497	606	732	829
	2.	Output at Boiler Outlet Sq. ft. Steam Radiation (240 B. T. U.)	1008	1650	2073	2523	3052	3460
	3.	Output at Boiler Outlet Sq. ft. Water Radiation (150 B. T. U.)	1615	2640	3320	4040	4870	5530
	4.	Output at Boiler Outlet Lbs. Steam per hour	250	410	515	627	758	858
	5.	Gals. Oil burned per hour	2.2	3.5	4.4	5.4	6.6	7.6
	6.	Evap. per pound Oil	15.8	16.2	16.2	16.1	15.9	15.6
	7.	Efficiency—per cent.	79.0	81.0	80.9	80.3	79.3	78.0
	8.	Flue Gas Temperature—°F.	360	449	509	575	656	725
	9.	Draft at Smoke Outlet— Inches Water	.01	.01	.02	.03	.06	.11
	10.	Size of Chimney	8x12x30	12x12x30	12x12x30	12x16x30	12x16x30	12x16x35
KNOWLTON WATERTOOB BOILER No. 25 Combustion Area 8.45 sq. ft.	1.	Output at Boiler Outlet Thousands B. T. U. per hour	282	460	628	790	893	993
	2.	Output at Boiler Outlet Sq. ft. Steam Radiation (240 B. T. U.)	1175	1920	2620	3300	3720	4140
	3.	Output at Boiler Outlet Sq. ft. Water Radiation (150 B. T. U.)	1880	3065	4190	5260	5930	6620
	4.	Output at Boiler Outlet Lbs. Steam per hour	291	473	649	815	919	1022
	5.	Gals. Oil burned per hour	2.5	4.0	5.5	7.0	8.0	9.0
	6.	Evap. per pound Oil	16.2	16.5	16.4	16.2	16.0	15.8
	7.	Efficiency—per cent.	81.0	82.4	82.0	81.0	80.0	79.0
	8.	Flue Gas Temperature—°F.	332	402	474	547	593	640
	9.	Draft at Smoke Outlet— Inches Water	.01	.01	.02	.04	.07	.11
	10.	Size of Chimney	8x12x30	12x12x30	12x16x30	12x16x30	12x16x30	12x16x35
KNOWLTON WATERTOOB BOILER No. 26½ Combustion Area 9.67 sq. ft.	1.	Output at Boiler Outlet Thousands B. T. U. per hour	336	532	709	897	1055	1228
	2.	Output at Boiler Outlet Sq. ft. Steam Radiation (240 B. T. U.)	1400	2220	2960	3740	4400	5130
	3.	Output at Boiler Outlet Sq. ft. Water Radiation (150 B. T. U.)	2240	3543	4730	5980	7030	8180
	4.	Output at Boiler Outlet Lbs. Steam per hour	346	548	730	924	1085	1264
	5.	Gals. Oil burned per hour	3.0	4.65	6.25	8.0	9.5	11.2
	6.	Evap. per pound Oil	16.1	16.4	16.3	16.05	15.9	15.75
	7.	Efficiency—per cent.	80.5	82.0	81.4	80.3	79.5	78.7
	8.	Flue Gas Temperature—°F.	340	408	476	550	612	685
	9.	Draft at Smoke Outlet— Inches Water	.01	.01	.02	.03	.05	.10
	10.	Size of Chimney	8x12x30	12x12x30	12x16x30	12x16x30	12x16x30	12x16x35
KNOWLTON WATERTOOB BOILER No. 27 Combustion Area 11.27 sq. ft.	1.	Output at Boiler Outlet Thousands B. T. U. per hour	338	664	913	1130	1330	1530
	2.	Output at Boiler Outlet Sq. ft. Steam Radiation (240 B. T. U.)	1410	2767	3800	4710	5540	6375
	3.	Output at Boiler Outlet Sq. ft. Water Radiation (150 B. T. U.)	2254	4430	6090	7530	8860	10200
	4.	Output at Boiler Outlet Lbs. Steam per hour	348	684	939	1162	1370	1575
	5.	Gals. Oil burned per hour	3.0	5.8	8.0	10.0	12.0	14.0
	6.	Evap. per pound Oil	16.15	16.4	16.3	16.2	15.9	15.65
	7.	Efficiency—per cent.	80.7	82.0	81.7	80.9	79.6	78.4
	8.	Flue Gas Temperature—°F.	320	417	494	565	636	705
	9.	Draft at Smoke Outlet— Inches Water	.01	.01	.02	.04	.06	.11
	10.	Size of Chimney	8x12x30	12x16x30	12x16x30	12x16x30	16x16x30	16x20x35

PERFORMANCE TEST DATA

KNOWLTON WATERTOOB BOILER No. 27½ Combustion Area 12.09 sq. ft.	1. Output at Boiler Outlet Thousands B. T. U. per bour	338	733	1025	1239	1443	1680
	2. Output at Boiler Outlet Sq. ft. Steam Radiation (240 B. T. U.)	1410	3055	4270	5160	6010	7010
	3. Output at Boiler Outlet Sq. ft. Water Radiation (150 B. T. U.)	2254	4886	6830	8260	9620	11200
	4. Output at Boiler Outlet Lbs. Steam per hour	348	753	1055	1275	1488	1730
	5. Gals. Oil burned per hour	3.0	6.4	9.0	11.0	13.0	15.4
	6. Evap. per pound Oil	16.15	16.4	16.3	16.1	15.9	15.6
	7. Efficiency—per cent.	80.8	82.0	81.5	80.7	79.5	78.2
	8. Flue Gas Temperature—°F.	310	423	510	579	646	728
	9. Draft at Smoke Outlet— Inches Water	.01	.01	.02	.04	.06	.11
	10. Size of Chimney	8x12x30	12x16x30	12x16x30	12x16x30	16x16x30	16x20x35
KNOWLTON WATERTOOB BOILER No. 28 Combustion Area 12.88 sq. ft.	1. Output at Boiler Outlet Thousands B. T. U. per hour	450	801	1130	1450	1650	1850
	2. Output at Boiler Outlet Sq. ft. Steam Radiation (240 B. T. U.)	1875	3340	4720	6050	6870	7720
	3. Output at Boiler Outlet Sq. ft. Water Radiation (150 B. T. U.)	3000	5340	7530	9670	11050	12350
	4. Output at Boiler Outlet Lbs. Steam per hour	463	825	1163	1492	1700	1905
	5. Gals. Oil burned per hour	4.0	7.0	10.0	13.0	15.0	17.0
	6. Evap. per pound Oil	16.1	16.4	16.2	16.0	15.8	15.6
	7. Efficiency—per cent.	80.7	82.0	81.1	80.0	79.0	78.0
	8. Flue Gas Temperature—°F.	334	427	521	615	678	740
	9. Draft at Smoke Outlet— Inches Water	.01	.01	.02	.04	.06	.10
	10. Size of Chimney	12x12x30	12x16x30	12x16x30	16x16x30	16x20x30	16x20x35
KNOWLTON WATERTOOB BOILER No. 29 Combustion Area 14.11 sq. ft.	1. Output at Boiler Outlet Thousands B. T. U. per hour	550	899	1182	1453	1705	2061
	2. Output at Boiler Outlet Sq. ft. Steam Radiation (240 B. T. U.)	2300	3750	4950	6060	7120	8600
	3. Output at Boiler Outlet Sq. ft. Water Radiation (150 B. T. U.)	3668	5995	7880	9680	11380	13750
	4. Output at Boiler Outlet Lbs. Steam per hour	566	926	1217	1495	1754	2120
	5. Gals. Oil burned per hour	5.0	7.95	10.5	13.0	15.5	19.0
	6. Evap. per pound Oil	15.8	16.2	16.2	16.0	15.75	15.55
	7. Efficiency—per cent.	79.0	81.0	80.9	80.2	78.9	77.7
	8. Flue Gas Temperature—°F.	350	435	500	570	640	735
	9. Draft at Smoke Outlet— Inches Water	.01	.01	.02	.04	.06	.12
	10. Size of Chimney	12x16x30	12x16x30	12x16x30	16x16x30	16x20x30	20x20x35
KNOWLTON WATERTOOB BOILER No. 30 Combustion Area 16.90 sq. ft.	1. Output at Boiler Outlet Thousands B. T. U. per hour	893	1175	1465	1789	2095	2488
	2. Output at Boiler Outlet Sq. ft. Steam Radiation (240 B. T. U.)	3720	4900	6100	7450	8730	10380
	3. Output at Boiler Outlet Sq. ft. Water Radiation (150 B. T. U.)	5940	7850	9770	11920	13990	16610
	4. Output at Boiler Outlet Lbs. Steam per hour	920	1215	1510	1841	2160	2562
	5. Gals. Oil burned per hour	8.0	10.4	13.0	16.0	19.0	23.0
	6. Evap. per pound Oil	16.0	16.2	16.16	16.0	15.8	15.5
	7. Efficiency—per cent.	79.9	81.0	80.9	80.0	78.9	77.5
	8. Flue Gas Temperature—°F.	400	452	512	580	650	740
	9. Draft at Smoke Outlet— Inches Water	.01	.01	.02	.04	.08	.20
	10. Size of Chimney	12x16x30	12x16x30	16x16x30	16x20x30	20x20x35	20x24x50

PERFORMANCE TEST DATA

KNOWLTON WATERTOOB BOILER No. 31 Combustion Area 19.98 sq. ft.	1. Output at Boiler Outlet Thousands B. T. U. per hour	1003	1515	1915	2337	2730	3165
	2. Output at Boiler Outlet Sq. ft. Steam Radiation (240 B. T. U.)	4190	6310	8000	9720	11390	13200
	3. Output at Boiler Outlet Sq. ft. Water Radiation (150 B. T. U.)	6720	10110	12800	15550	18220	21190
	4. Output at Boiler Outlet Lbs. Steam per hour	1037	1561	1979	2410	2815	3265
	5. Gals. Oil burned per hour	9.0	13.4	17.0	21.0	25.0	29.6
	6. Evap. per pound Oil	16.0	16.2	16.15	15.95	15.65	15.35
	7. Efficiency—per cent.	80.1	81.0	80.8	79.9	78.3	76.7
	8. Flue Gas Temperature—°F.	390	470	538	613	690	775
	9. Draft at Smoke Outlet— Inches Water	.01	.02	.04	.08	.18	.41
	10. Size of Chimney	12x16x30	16x16x30	16x20x30	20x20x35	20x24x40	24x24x70
KNOWLTON WATERTOOB BOILER No. 32 Combustion Area 22.51 sq. ft.	1. Output at Boiler Outlet Thousands B. T. U. per hour	1315	1785	2230	2635	3030	3510
	2. Output at Boiler Outlet Sq. ft. Steam Radiation (240 B. T. U.)	5470	7450	9290	11000	12630	14650
	3. Output at Boiler Outlet Sq. ft. Water Radiation (150 B. T. U.)	8770	11920	14890	17550	20200	23400
	4. Output at Boiler Outlet Lbs. Steam per hour	1355	1840	2290	2720	3120	3620
	5. Gals. Oil burned per hour	12.0	16.0	20.0	24.0	28.0	33.0
	6. Evap. per pound Oil	15.7	16.0	15.9	15.7	15.5	15.2
	7. Efficiency—per cent.	78.4	80.0	79.7	78.7	77.6	76.2
	8. Flue Gas Temperature—°F.	412	480	542	610	676	758
	9. Draft at Smoke Outlet— Inches Water	.02	.03	.05	.13	.27	.75
	10. Size of Chimney	16x16x30	16x16x30	20x20x30	20x24x35	24x24x50	24x24x100
KNOWLTON WATERTOOB BOILER No. 33 Combustion Area 25.0 sq. ft.	1. Output at Boiler Outlet Thousands B. T. U. per hour	1431	2062	2553	2965	3360	3720
	2. Output at Boiler Outlet Sq. ft. Steam Radiation (240 B. T. U.)	5970	8610	10630	12370	14000	15510
	3. Output at Boiler Outlet Sq. ft. Water Radiation (150 B. T. U.)	9550	13760	17100	19810	22410	24800
	4. Output at Boiler Outlet Lbs. Steam per hour	1475	2130	2630	3060	3460	3830
	5. Gals. Oil burned per hour	13.0	18.5	23.0	27.0	31.0	35.0
	6. Evap. per pound Oil	15.8	16.0	15.9	15.75	15.5	15.2
	7. Efficiency—per cent.	79.0	80.0	79.7	78.9	77.6	76.1
	8. Flue Gas Temperature—°F.	410	500	573	638	704	770
	9. Draft at Smoke Outlet— Inches Water	.02	.03	.09	.22	.44	.75
	10. Size of Chimney	16x16x30	16x20x30	20x24x30	24x24x50	24x24x70	24x24x100
KNOWLTON WATERTOOB BOILER No. 34 Combustion Area 25.0 sq. ft.	1. Output at Boiler Outlet Thousands B. T. U. per hour	1765	2362	2780	3190	3565	3942
	2. Output at Boiler Outlet Sq. ft. Steam Radiation (240 B. T. U.)	7370	9860	11600	13310	14850	16450
	3. Output at Boiler Outlet Sq. ft. Water Radiation (150 B. T. U.)	11790	15740	18590	21300	23800	26300
	4. Output at Boiler Outlet Lbs. Steam per hour	1820	2439	2880	3300	3690	4080
	5. Gals. Oil burned per hour	16.0	21.2	25.0	29.0	33.0	37.2
	6. Evap. per pound Oil	15.8	16.0	15.9	15.75	15.5	15.2
	7. Efficiency—per cent.	79.0	80.0	79.7	78.8	77.5	76.0
	8. Flue Gas Temperature—°F.	432	513	576	640	704	770
	9. Draft at Smoke Outlet— Inches Water	.02	.04	.08	.21	.43	.75
	10. Size of Chimney	16x20x30	20x20x30	20x24x35	24x24x50	24x24x70	24x24x100


F
F'
J
H
S
G
E
Q
M
N
P
O
L
K
R
C
D
T
B
A
REFACTORY.
A
NOZZLE TYPE REAR END
A-.7 TO .8 OF FURNACE.
REFACTORY.
A
NOZZLE TYPE -FRONT END.
A-.7 TO .8 OF FURNACE.
B
ATOMIZING CUP TYPE AND POT TYPE
A - DIA. OF BOWL = WIDTH OF FURNACE LESS 2"
B - Ø OF BURNER = .6 TO .7 OF LENGTH OF FURNACE.

DIMENSIONS OF KNOWLTON WATERTOOB HEATING BOILERS

NUMBER OF BOILER	20	21	22	23	24	25	26½	27	27½	28	29	30	31	32	33	34
A—Height of Boiler—in.	55¼	56	58	59½	62½	62½	71	72	73	72	74	81	81	82½	82½	85
B—Height of Boiler Shell—in.	43¼	44	46	47½	50½	50½	59	59	61	60	62	69	69	70½	70½	73
C—Height of Boiler Water Line—in.	47	48	50	51½	54	54	60½	63	62½	64	65	69	69	70	70	73
D—Height CL. Fire Door—in.	25¾	25¾	25¾	25¾	25¾	25¾	26½	26½	26½	26½	26½	27	27	27	27	27
E—Height CL. Smoke Outlet—in.	39	39¾	42	42½	44½	44½	50	53	50¾	53½	55	58½	58½	58½	58½	60¾
F—Width Smoke Outlet—in. outside	11¾	11¾	14¾	14½	14¾	14¾	19¾	19¾	19¾	22¾	22¾	24	28	28⅛	28⅛	30¾
F'—Height of Smoke Outlet—in. outside	5¾	6¾	6¾	8	9¾	9¾	9¾	9¾	9¾	9¾	9¾	10⅜	10⅜	12⅜	12⅜	12⅜
G—Height of Base—in.	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
H—Width of Boiler—in.	26	29	29	32	32	35	35	35	35	35	35	39½	39½	43½	43½	43½
J—Width overall of Boiler—in.	29	32	32	35	35	38	38	38	38	38	38	42½	42½	46½	46½	46½
K—Length of Boiler—in.	25	31	37	43	49	49	56	64	68	72	78	85	99	99	109	109
L—Length overall of Boiler—in.	36	42	48	54	60	60	67	75	79	83	89	96½	110½	110½	120½	120½
M—Smoke Outlet Extension—in.	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
N—Location of Outlets—Steam—in.	4¼	4½	13¾	13	12¼	12¼	14	23	20¾	22½	21¾	21½	31½	31½	29¼	29¼
O—Location of Outlets—Steam—in.	....	....	....	29½	36¼	36¼	41	50	46¼	49	56	55	67½	67½	79	79¼
N—Location of Outlets—Water—in.	....	....	....	13	12¼	12¼	14	23	20¾	22½	21¾	21½	31½	31½	29¼	29¼
O—Location of Outlets—Water—in.	20½	26½	31¾	29½	36¼	36¼	41	50	46¼	49	56	55	67½	67½	79¼	79¼
P—Location of Returns—in.	4¼	4½	4¾	4½	4¼	4¼	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½
Q—Location of Returns—in.	15¼	15½	15½	15½	16	16	16	16½	16½	16½	16½	16½	16½	16½	16½	16½
R—Length of Base—in.	25	31	37	43	49	49	56	64	68	72	78	85	99	99	109	109
S—Width overall—Base—in.	30	33	33	36	36	39	39	39	39	39	39	43	43	47	47	47
T—Length of Base Opening—in.	18	18	18	18	18	22	22	22	22	22	22	22	22	22	22	22
U—Width of Base Opening—in.	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

KNOWLTON OIL - GAS - COPPER TUBES

STEAM	Boiler No.	20	21	22	23	24	25	26½	27	27½	28	29	30	31	32	33	34
	Capacity—Guaranteed Designed Loads sq. ft.	850	1200	1500	2200	2660	3185	3945	4710	5370	6040	6880	8300	9720	11400	12400	13160
HOTWATER	Boiler No.	320	321	322	323	324	325	326½	327	327½	328	329	330	331	332	333	334
	Capacity—Guaranteed Designed Loads sq. ft.	1360	1920	2400	3520	4257	5100	6310	7530	8600	9680	11000	13280	15550	18240	19850	21070

SPECIFICATIONS

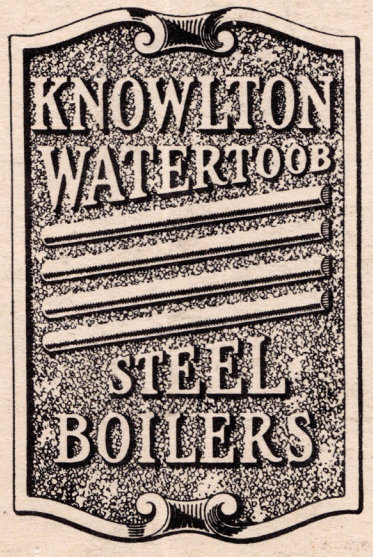
See Pages 16 and 17 for Dimensions - Boiler - Setting

Heating Surface—Equivalent Steel—sq. ft.	57	90	113	147	181	221	277	307	355	416	474	553	667	748	845	964
Disengagement Area—sq. ft.	4.2	5.6	7.0	9.0	10.0	11.2	12.5	14.2	14.5	16.0	17.5	20.5	23.8	26.0	28.8	28.8
Steam Space—cu. ft.	2.0	3.1	3.7	5.2	6.0	7.1	8.0	9.1	9.5	10.3	11.3	15.5	18.0	22.0	24.2	24.2
Water Content—gals.	41	53	64	79	90	97	118	128	130	146	164	220	255	276	298	305
Width of Firebox—in.	20	23	23	26	26	29	29	29	29	29	29	32	32	36	36	36
Length of Firebox—in.	18	24	30	36	42	42	48	56	60	64	70	76	90	90	100	100
Area Smoke Opening—sq. in.	50	58	76	88	108	108	150	150	150	182	182	206	245	294	294	325
Size of Chimney—One Boiler—in.	8x12	8x12	12x12	12x12	12x16	12x16	12x16	12x16	12x16	16x16	16x20	20x20	20x20	20x20	24x24	24x24
Minimum Height Chimney—ft.	30	30	30	30	30	30	30	30	30	30	30	35	35	40	60	60
Size of Chimney—2 Boilers—in.	12x12	12x16	12x16	12x16	16x16	16x16	16x20	16x20	20x20	20x20	20x24	24x24	24x24	24x24	24x30	24x30
Minimum Height Chimney—2 Boilers—ft.	30	30	30	30	30	30	30	30	30	30	30	35	35	40	60	60
No. & Size—Steam Outlets—in.	1–3	1–4	1–4	2–4	2–5	2–5	2–5	2–5	2–5	2–5	2–6	2–6	2–6	2–6	2–6	2–6
" " —Returns—in.	2–2½	2–3	2–3	2–3	2–4	2–4	2–4	2–4	2–4	2–4	2–5	2–5	2–5	2–5	2–5	2–5
No. & Size—H. W. Outlets—in.	2–3	2–4	2–4	2–4	2–5	2–5	2–5	2–5	2–5	2–5	2–6	2–6	2–6	2–6	2–6	2–6
" " —Returns—in.	2–3	2–4	2–4	2–4	2–5	2–5	2–5	2–5	2–5	2–5	2–6	2–6	2–6	2–6	2–6	2–6
Size of Safety Valve—in.	¾	1	1¼	1½	1½	2	2	2	2	2	2½	2½	3	3	3	3½
Boiler Covering Required—sq. ft.	18	24	28	35	42	43	54	64	67	73	81	97	114	122	134	139

GUARANTEE

WE guarantee our goods to be free of defects in material and workmanship, and will deliver to transportation company, without charge, F.O.B. Factory or convenient shipping point, part or parts necessary to replace defects of this kind, providing claims are presented within 90 days after receipt of goods. We further guarantee that the printed ratings in this bulletin are correct, and were determined by actual Performance Tests.

ORR & SEMBOWER, Inc
READING, PENNSYLVANIA
U. S. A.



Printed in U. S. A.

Miller, Reading, Pa.